

TITLE OF THE INVENTION

Method and Apparatus for Preventing Disruptions in Set-Top Terminal Function Due to the Download of Updated Programming or Data to the Set-Top Terminal.

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FIELD OF THE INVENTION

The present invention relates to the field of cable television. More specifically, the present invention relates to the field of programming and updating the programming or data in a set-top terminal which connects a viewer's television, and possibly other electronic equipment, to the cable network. In particular, the present invention relates to a method and apparatus for preventing disruptions in cable television service due to the downloading of updated programming or data to the set-top terminal via the cable network.

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BACKGROUND OF THE INVENTION

As shown in Fig. 2, a typical cable television network includes a signal headend (201). The signal headend (201) is a facility maintained by the cable television company from which the cable television signal is sent to subscribers over the cable network (203).

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Each subscriber to the cable service is typically provided with a set-top terminal (202). The set-top terminal (202) is a box of electronic equipment that interfaces the subscriber's television, and possibly other electronic equipment, with the cable network (203).

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The signal headend (201) broadcasts the cable television signal over the cable network (203) to the population of set-top terminals (202) possessed by

individual subscribers. In addition to being connected to the cable network (203), each set-top terminal (202) also has a connection (204) to the subscriber's television and/or other electronic equipment to allow the subscriber to make use of the signals from the cable network (203).

The set-top terminals (202) include electronic memory (206) and a computer processor (205) which is programmed using the memory (206) to process and make use of the signals transmitted by the headend (201) over the cable network (203). The set-top terminals (202) may be programmed to provide a variety of services including decoding premium cable channels and providing electronic programming guides.

Periodically, as the cable system evolves, new features may become available or signal distribution may be refined in such a manner that the programming in the set-top terminal (202) needs to be updated in order to allow the terminal (202) to continue to provide the services of the cable system to subscribers with peak efficiency. If a technician must visit the home of each subscriber to upgrade the programming in the set-top terminals (202), the implementation of the upgrade becomes time-consuming and expensive.

To avoid these problems, new programming for the set-top terminal (202) can be transmitted to the terminal (202) over the cable network (203) itself. In this way, upgraded programming and data can be distributed automatically from the headend (201) without requiring a visit to each set-top terminal (202) individually.

However, additional problems arise in downloading updated programming and data over the cable network (203) to the set-top terminals (202). For instance, in

conventional systems, when a set-top terminal (202) detects that data or updated programming is being offered by the headend (201) for downloading, the set-top terminal (202) automatically accepts the download and may erase existing data or programming from memory (206) in favor of the newly-received data or programming.

This will result in an interruption of service because the set-top terminal (202) will be unable to continue providing its normal functions while it is receiving new data and programming to replace that which has been erased. If the subscriber is attempting to watch television or use the set-top terminal during this time, the subscriber may be interrupted. These interruptions of the set-top terminal's normal functions may be completely unnecessary if the set-top terminal already happens to have the same version of the data or programming being offered for download over the network (203).

It may be possible to minimize the impact of this problem by only broadcasting updated data or programming to the set-top terminals (202) during off-peak hours when television is not commonly watched, such as between one and five a.m. However, this requires additional staffing for the headend facility (201) during those hours which is expensive. Additionally, there are subscribers who use their television service during all hours, even if only to record programming which will be watched later. Therefore, the interruption of set-top terminal functions during data download poses significant and sometimes unnecessary problems.

These problems may be exacerbated if the updated programming or data is broadcast to the set-top

terminals (202) on an in-band channel as is anticipated in the near future. If the incoming data is on an in-band channel, the set-top terminal (202) will have to change the channel from the one the subscriber is watching or recording in order to tune to the channel over which the download is being provided. This will make normal television viewing and recording during the period of the download impossible.

Similar disruptions of service can occur when the set-top terminal is switching from running existing programming to the execution of new programming received in a download from the headend (201).

Consequently, there is a need in the art for a method and apparatus for preventing disruptions in cable television service due to the downloading and implementation of updated programming or data to the set-top terminal via the cable network.

SUMMARY OF THE INVENTION

It is an object of the present invention to meet the above-described needs and others. Specifically, it is an object of the present invention to provide a method and apparatus for preventing disruptions in set-top terminal function due to the downloading of updated programming or data via the cable network.

Additional objects, advantages and novel features of the invention will be set forth in the description which follows or may be learned by those skilled in the art through reading these materials or practicing the invention. The objects and advantages of the invention may be achieved through the means recited in the attached claims.

To achieve these stated and other objects, the present invention may be embodied and described as a

set-top terminal for connecting a subscriber to a cable network that operates to prevent unnecessary and undue interruptions of service when accommodating a download of new programming or data over the cable network. A
5 typical set-top terminal that is capable of implementing the present invention may include a processor and a memory unit for storing programming or other data used by the processor. When a download of data or programming is offered to the set-top terminal
10 over the cable network, the processor only accepts the download and records the download in the memory unit when one or more predetermined criteria are satisfied. These criteria may be any conditions that tend to indicate that acceptance of the download will not
15 interfere with the subscriber's use of the set-top terminal.

The criteria for acceptance of a download may be built into the set-top terminal or may be downloaded to the set-top terminal over the computer network. The
20 criteria may include such factors as the time of day; or whether the set-top terminal is turned off. Additionally, the set-top terminal may signal the subscriber that a download is available and request permission to accept the download. A positive response
25 by the subscriber to the request for permission to accept the download may be a criterion for accepting the download. Additionally, the set-top terminal may verify that the data or programming offered in the download is not already resident in memory before
30 determining whether the one or more predetermined criteria are satisfied.

When the criteria for accepting a download have been met, the set-top terminal accepts the download and receives the updated programming or data. This may

entail tuning to a specified channel to receive the incoming download. In accepting the download, the processor will typically erase data in the memory unit and replace the erased data with the upgraded data or programming from the download.

Additionally, once a download has been received, the set-top terminal may need to terminate the programming currently running on the terminal in favor of the new, upgraded programming received in the download. Under the present invention, the processor will again seek to satisfy one or more predetermined criteria before interrupting set-top terminal functioning in order to switch to execution of the new programming.

The present invention also encompasses a method for minimizing interruptions to the use of a set-top terminal for connecting a subscriber to a cable network where the interruptions result from downloading or implementing data or programming to the set-top terminal over the cable network.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate the present invention and are a part of the specification.

Together with the following description, the drawings demonstrate and explain the principles of the present invention.

Fig. 1 is a flow chart of a method of managing the downloading of data or programming to a set-top terminal over a cable network without significant disruption in terminal functions according to the present invention.

Fig. 2 is a block diagram of a cable television system, including a headend facility, a cable network

and a population of set-top terminals, with which the present invention is practiced.

Fig. 3 is a flow chart showing execution of downloading and upgrading instructions within the method illustrated in Fig. 1.

Fig. 4 is a flow chart showing execution of alternative downloading instructions within the method illustrated in Figs. 1 and 3.

In the drawings, identical reference numerals indicate identical structure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Stated in broad principle, the present invention involves preventing the computer processor (205) of the set-top terminal from accepting every download of data or programming offered by the headend over the cable network unless predetermined criteria are satisfied. Consequently, unnecessary interruptions of the terminal functions or television signal usage are prevented.

Using the drawings, the preferred embodiments of the present invention will now be explained. As shown in Fig. 1, the present invention begins with a set-top terminal (202) receiving a signal indicating that programming or data is available for download over the cable network (203). See step (101) in Fig. 1. The set-top terminal (202) may also be informed of the channel on which the download will be made available if that channel is an in-band channel (102).

Rather than immediately accepting the new download, under the principles of the present invention, certain criteria must be met before the set-top terminal (202) will abandon existing data or programming in favor of the download being offered. After the set-top terminal (202) is signaled that a download is being offered and

the channel over which the download will be made, the set-top terminal (202) will determine whether it has the criteria that must be met for accepting a new download (103). The criteria may be downloaded to the terminal during initialization or a programming update, or may be built into the set-top terminal's factory-installed firmware.

If the set-top terminal (202) determines that it does not have the criteria for authorizing acceptance of an offered download, it may attempt to download the criteria from a control channel being broadcast by the headend (104). If no such criteria are programmed into the set-top terminal (202) or available for download, the set-top terminal (202) can be programmed to either operate conventionally and accept all incoming downloads, or to refuse to accept any downloads until criteria for authorizing a download are provided.

Once the criteria for accepting a download are obtained or located, the process continues. However, before the criteria for authorizing an interruption for accepting a download are checked, the set-top terminal (202) will verify that the data or programming being offered is a new version or does, in fact, represent an update from the data or programming the set-top terminal (202) already has (105). For example, it may be possible that a set-top terminal (202) which has been newly added to the population already has the latest data or programming which is being offered to the older terminals (202) in the population as a download over the network (203). In such a case, the set-top terminal (202) should refuse to interrupt its functioning to accept a download containing programming it already has.

The headend facility (201) will append a version identifier to offered downloads of data or programming so that the set-top terminals (202) can determine if the information being offered is new and, therefore, should potentially be accepted. As shown in Fig. 1, if the offered download is not new to the set-top terminal (202), the process reverts to step (101) in which the set-top terminal (202) waits for the next offering of a download over the network (203).

The offered download may also specify a class of set-top terminals to which it pertains. Thus, the set-top terminal (202) may also refuse a download unless the download is specified as being for the class of terminals to which that terminal belongs.

However, if the offered download does represent upgraded data or programming and is specified as being for that terminal, the set-top terminal (202) following the method of the present invention will next determine if the interruption criteria for accepting a download are met (106). The criteria for authorizing a download may include one or more conditions that would indicate that interruption of service to accept a download is acceptable at that time. For example, if the set-top terminal (202) is turned off or is in the logical off state, the subscriber is clearly not using the terminal (202) and will not be annoyed at a service interruption to accept a download. Therefore, the terminal (202) being off may be a criterion that authorizes acceptance of a download.

Alternatively, if the set-top terminal (202) is in use when a download is offered, the set-top terminal (202) may query the subscriber whether he or she wishes to accept the download. This query may be displayed on the television attached to the set-top terminal (202)

or may be made through the instrumentality of the terminal (202) itself. If the subscriber signals acceptance of the download, the terminal (202) may then interrupt service and accept the download without annoying the subscriber.

Another criterion that may be used is the time of day. Certain hours, e.g. off-peak hours, may be designated as a criterion that completely or partially authorizes acceptance of a download. Other criteria that could be used by the set-top terminal (202) to determine when acceptance of a download will be the least intrusive to a subscriber will be apparent to those skilled in the art and are within the scope of the present invention.

As will also be apparent, any or all of these criteria may be used singly or in combination with each other. For example, the set-top terminal (202) may first verify that the set-top terminal (202) is turned off, but may then also determine the time of day so as to assess whether the set-top terminal (202) is likely to be turned on and used by the subscriber in the immediate future when a download is being accepted.

Additionally, if the viewer is using an on-screen graphics application which can be supported by the set-top terminal (202) while also downloading programming over the network, downloading may be authorized. This would be the case where a second, separate memory unit is provided for accepting and storing the downloading programming and the download is offered on an in-band channel.

If the criteria for accepting a download are not met, the set-top terminal (202) will not accept the download. The set-top terminal (202) may be programmed to periodically or continuously reassess the criteria

and accept the download when the criteria become satisfied.

5 Additionally, the signal alerting the set-top terminal (202) that a download is available may include a deadline by which the terminal (202) must accept the download, if the terminal (202) determines that it needs or is intended to receive the download, e.g., the download represented updated programming or data compared to that already possessed by the terminal 10 (202). If a deadline for accepting the download is set and the set-top terminal (202) has not been able to satisfy alternative criteria for accepting the download, the set top terminal (202) will, on that deadline, suspend service as necessary to accept the 15 download (107). This provides more control to the system operator as to downloading new programming to the population of set-top terminals (202).

20 However, there might be the need for some flexibility in implementing the deadline for upgrade. For example, if the disruption to receive a download would interrupt a VCR recording a program, a pay-per-view event or other dedicated use of the set-top terminal, it may be preferable to delay the deadline until the disruption will cause less inconvenience to the user of the terminal. Set-top terminals may be 25 equipped with a "remote control lockout" mode that the viewer may invoke to prevent accidental channel changes or other remote control errors during dedicated use of the set-top terminal (202). The terminal's (202) built in VCR timer automatically invokes a similar "record lockout" mode during a time period assigned for VCR 30 recording.

Under the principles of the present invention, the set-top terminal may be programmed to respect these

lockout modes and defer a deadline to download an upgraded programming version if any such lockout mode is detected. Additionally, the set-top terminal may include a separate, additional "lockout" feature which can be activated by the viewer to prevent any such controllable disruptions in service as those associated with accepting downloaded programming or switching between programming versions.

When the criteria for accepting a download are met, the set-top terminal (202) tunes to the channel on which the download is being offered, if necessary, and determines if the download is, in fact, being offered at that time (108). If the download is being offered, the set-top terminal (202) then proceeds to accept and, under circumstances described below, implement the new programming in favor of the older programming running on the terminal (202). See step (109).

Finally, with the update complete, the set-top terminal (202) returns to the state in which it waits to be signaled that a new download is being offered. (101). In this way, the interruptions resulting from acceptance of a download by the set-top terminal (202) are minimized as is the annoyance caused to subscribers from such interruptions.

The process of replacing an existing, executing programming object with a newly downloaded object will now be described in detail. When the set-top terminal has determined that the programming being offered over the network (203) is new (105), that the criteria for accepting a download are met (106), the set-top terminal acquires the data stream for the incoming programming (108). As shown in Fig. 3, upon acquiring the data stream (110), the set-top terminal receives instructions (111) with the downloaded programming for

implementing that programming as a replacement for the software or firmware already running on or resident in the set-top terminal (202). These instructions may also optionally include a deadline by which the new programming in the download must be implemented and running on the set-top terminal (202).

Under the present invention, there are two basic instruction sets which might be provided to the set-top terminal to cause it to implement programming other than that currently running on the terminal (112). These two basic instruction sets can be described as a "typical" instruction set which will usually be used when an upgrade of programming is to be made, and an "erase new" instruction set used in testing or remediating programming.

The typical instruction set will direct the set-top terminal (202) to erase the existing programming or the old firmware without resetting. When such an instruction is received, the set-top terminal (202) will first determine whether or not it is executing the most recent version of programming that it has received (113). In some rare cases, the set-top terminal (202) may have the new programming that is being offered over the network (203) already stored in memory, but be running an older version. Where this is the case, it would obviously be an unwarranted interruption in service for the set-top terminal (202) to accept the incoming download of programming already stored in memory. Consequently, the set-top terminal (202) will first determine if it is executing the latest version of the programming being offered on the network (203) that it already has (113).

If the set-top terminal (202) finds a version of the offered programming in memory that is newer than

the version being executed, the set-top terminal (202) will reset (114). After the reset, the most recent version of programming will automatically be executed (114).

5 Then, the set-top terminal (202) can once again compare the version of programming being executed with that being offered over the network (203). If the
10 executing programming, after the reset, is the same version being offered over the network (203), the set-top terminal (202) has avoided an unnecessary extended interruption of service to download the programming from the network (203) that it already had.

15 Once the set-top terminal (202) has established that it is running the most recent version of programming that it possesses, that the programming being offered on the network (203) is a still more recent version, and that the criteria for accepting a download are met (106), the set-top terminal (202) will
20 erase any old versions of the programming in memory which are not being executed (116) in order to make room for acceptance of the incoming programming from the network (203). The unique identifier from the incoming programming is recorded for comparison to that of later offerings of programming (116). The set-top
25 terminal (202) also maintains a record of the progress of the download process for the incoming updated programming module.

30 The set-top terminal (202) accepts and stores all data identified as part of the programming module being offered for download (116). Based on the transmission protocol, the incoming programming module may be transmitted in multiple packets, which may be received in any order and reassembled into an executable object. Once the entire programming object is acquired,

assembled and stored, it is subjected to a checksum integrity check (117). Upon passing the integrity check, the new programming is ready for execution.

Under the typical instruction set, the set-top terminal (202) will cease executing its existing programming in favor of the newly acquired programming under any of several conditions. First, if the set-top terminal (202) is powered, i.e., plugged in, but is turned "off," i.e., the user is not currently using the terminal (202), the set-top terminal (202) will halt the executing older programming and execute the newer, downloaded programming (118, 119). Or, if the set-top terminal (202) is in use, but detects a commercial break in the programming being watched by the viewer, implementation of the newer programming (119) may be initiated. Disruption during a commercial break is much less likely to inconvenience the viewer.

Alternatively, if the set-top terminal (202) is reset for any reason, the newly acquired programming will automatically be executed in favor of any older version as noted above (120, 121). The reset may be caused manually at the set-top terminal (202) or may be initiated by the cable television service provider with a reset signal transmitted over the cable network (203). In either situation, the inconvenience to the subscriber due to the switch between software versions can and should be minimized.

Finally, if a deadline for implementation is associated with the newly acquired programming, the set top terminal (202) will, on that deadline, terminate the execution of the older programming and implement the new version (122, 119). This allows a system controller to force the upgrade at a particular time if necessary to accommodate some change being made system-

wide which requires all set top terminals (202) to be running the latest programming. Such a consideration may override concerns about a temporary inconvenience to individual subscribers due to service interruption associated with switching to a newer version of programming.

However, there might be the need for some flexibility in implementing the deadline for upgrade. For example, if the switch to the new programming version would interrupt a VCR recording a program, a pay-per-view event or other dedicated use of the set-top terminal, it may be preferable to delay the deadline until the disruption will cause less inconvenience to the user of the terminal. Set-top terminals may be equipped with a "remote control lockout" mode that the viewer may invoke to prevent accidental channel changes or other remote control errors during dedicated use of the set-top terminal (202). The terminal's (202) built in VCR timer automatically invokes a similar "record lockout" mode during a time period assigned for VCR recording.

Under the principles of the present invention, the set-top terminal may be programmed to respect these lockout modes and defer the switch to an upgraded programming version if any such lockout mode is detected. Additionally, the set-top terminal may include a separate, additional "lockout" feature which can be activated by the viewer to prevent any such controllable disruptions in service as those associated with accepting downloaded programming or switching between programming versions.

As another alternative, if the set-top terminal (202) is turned on and actively providing service to a viewer, the terminal (202) might advise the viewer that

an updated programming image has been received and is waiting to be executed. The terminal might so advise the viewer through an on-screen display message or via a display on the set-top terminal (202) itself. If the viewer signals consent for switching from the older, executing programming to the newer, downloaded programming, the set-top terminal (202) can proceed to step (119), terminate the execution of the older programming and execute the newer, downloaded programming without annoying the viewer.

The foregoing describes the "typical" instruction set provided with new programming over the network for implementing the new programming in favor of existing programming in each set-top terminal (202). However, the second instruction set may sometimes be called for. The second "erase new" instruction set directs the set-top terminal (202) to erase its newest programming and reset.

This second instructional set may be used when the cable system operator has transmitted a programming version to set-top terminals on a trial basis or has discovered a problem with programming that has been transmitted such that it becomes necessary to have the set-top terminals (202) revert to the previous version of the programming. Upon receipt of the instructional set to erase the newest programming and reset (112), the set-top terminal (202) will identify the most recent version of the appropriate programming (123) and erase it from memory (124). As shown in Fig. 4, the set-top terminal (202) then resets (125) which causes the execution of the older (now most recent) version of the programming, which is still resident in memory (126).

5 In the various processes described above in which
programming is upgraded in the set-top terminal (202),
the set-top terminal (202) regularly possess two
subsequent versions of a programming object, for
example, an older version which is executing and a
newer version waiting for conditions to obtain under
which it will be executed. After a switch, the set-top
terminal (202) will have the newer, executing version
of the programming and the older version which has now
10 had its execution terminated.

To accommodate this usual residence of two
successive versions of a programming object or firmware
image, the programming is preferably position-
independent within memory such that it can be executed
15 in the FLASH memory regardless of the absolute address
to which it is loaded. This will simplify the design
of the loader and minimize the cost. However, this
feature is not feasible for all microprocessor
firmware.

20 Without position-independence, there are at least
two ways to manage dual firmware images. Either
firmware image may be copied to RAM at a known location
in order to execute. Alternatively, each download
might include two versions of the firmware, one for
25 execution from the "upper" half of the FLASH memory and
one for execution from the "lower" half of the FLASH
memory. The set-top terminal can then acquire the
appropriate version depending on which half of the
FLASH memory is vacant for storing the incoming
30 download.

Alternatively, two independent and, preferably,
identical FLASH memory components could be provided.
Each memory component would separately contain an image
of the programming, newer and older versions. At the

expense of providing an additional memory component this would eliminate the problem of properly locating within a single memory device each independent programming image. Moreover, the terminal (202) 5 firmware will not need extra logic to partition a single memory component, but would require I/O hardware logic for alternating between the two memory components as needed.

10 Additionally, the transmitted programming may be compressed so that it takes less time to transmit and requires less space to store in FLASH memory. With such compression, the programming could then be decompressed in RAM and executed from there following the decompression.

15 As noted above, the memory used for storage of the downloaded programming will typically be FLASH memory, but could alternatively be battery-backed RAM or other writable, non-volatile memory.

20 It is also possible to prevent set-top terminals which are known not to need or be compatible with a particular download from even receiving the offered download. In emerging cable networks, each set-top terminal will be uniquely addressable. Consequently, the system controller could selectively transmit the 25 new programming to a defined subset of terminals rather than broadcasting the download to all terminals in the system.

30 Another way to minimize the interruptions associated with receiving new programming downloaded over the cable network is to have a dual processor system. The dual processor system includes a dedicated processor which manages the downloading of the new programming in the background while a primary processor continues to execute the existing programming providing

a user interface even while the download is in progress.

Without a dual-processor system, the priority of the task taking care of the download can be set appropriately, with respect to other tasks handling the platform services and the user interface, such that latency or disruption in the user interface is minimized.

The preceding description has been presented only to illustrate and describe the invention. It is not intended to be exhaustive or to limit the invention to any precise form disclosed. Many modifications and variations are possible in light of the above teaching.

For example, some of the steps in the method of the present invention can be reordered without departing from the spirit and scope of the present invention. For instance, the set-top terminal (202) may verify that the offered download is a new version of data or programming (105) compared with what is already stored in memory (206) before locating or downloading the criteria for accepting a download (103).

The preferred embodiment was chosen and described in order to best explain the principles of the invention and its practical application. The preceding description is intended to enable others skilled in the art to best utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims.